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« 11 » If, as Halprin suggests, the "confusion of our politics" is equally a result of a flawed design process that is too dependent on narrowly defined goals and insufficiently sensitive to feedback, then, perhaps, it is not going too far to expand Glanville's audacious claim that science is but a subset of design and make a similar claim regarding governance; a term that is, after all, also commonly understood to be virtually synonymous with the term "cybernetics." A conception of governance informed by the kind of second-order cybernetic approach to design espoused by Glanville and encapsulated in Sweeting's article would have no option but to acknowledge openly the inevitability of error and eliminate the peddling of supposedly iron-clad, fool-proof "solutions" in which the politicians of every liberal democracy currently traffic. And where might that lead us? But that is a conversation for another time.

« 12 » Sweeting's article does valuable work in consolidating Glanville's legacy of design cybernetic theorization as it evolved alongside a growing awareness within the design research community that first-order, non-reflexive "scientific" models are insufficient to deal with the emergent functional, aesthetic and ethical complexities of actual design practice. This provides a robust foundation from which a whole generation of cybernetic designers influenced by Glanville (Thomas Fischer, Candy Herr, Michael Hohl, Tim Jachna and others) can further develop and disseminate this rich body of theory and practice to the generations to come. As a theorist/practitioner who independently evolved a recursive, conversational approach to design so thoroughly embodying the ethical commitments of second-order cybernetics, an additional reflection upon the work of Halprin has much to offer this on-going endeavour.

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Understanding Design from a Second-Order Cybernetics Perspective: Is There a Place for Material Agency?

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> Upshot • This commentary supports Sweeting's case for the relationship between the design tradition, second-order cybernetics and second-order science. It argues, however, that the extension of this argument to other intellectual traditions and areas of practice is complicated by differing views of material agency.

« 1 » The main focus of Ben Sweeting's target article is to examine the terms "design" and "second-order cybernetics," together with the practice designated by them, and to discuss their relationship. This task is simply described, but leads inexorably into deep waters, in part because of the entangled relationship between the terms, and in part because both terms are contested. In the main, Sweeting navigates this complexity with skill, but inevitably there are loose ends in the argument, which are worth pulling on to see if they lead to further insight.

« 2 » The argument is founded on Sweeting's analysis of Ranulph Glanville's ideas on design and second-order cybernetics (SOC), a task that he is particularly well-positioned to undertake, given his long relationship with Glanville as both a student and a collaborator. Sweeting cites Glanville as stating that "cybernetics is the theory of design and design is the action of cybernetics" (§2), and reports that "Glanville […] characterises all research as being a design-like activity" (§14) and that he "recognises design research as a self-reflexive activity of researching research" (§15). On the basis of Glanville's work, exemplified by the above quotations, Sweeting makes the core proposal of the article, suggesting that

> "Glanville's understanding of design, and particularly his […] account of the relations between design and science […], allows us to view the currently expanding field of design research as a contemporary variety of SOC practice." (§6)

This proposal is both well-founded and useful.

« 3 » I also find Glanville's argument regarding the relationship between science and design, and Sweeting's discussion of it, to be convincing: "Design is, it follows, the more general case and, therefore, 'it is inappropriate to require design to be 'scientific': for scientific research is a subset (a restricted form) of design…" (§7). The argument is in line with the critique made by authors such as Stuart Umpleby (2014) and Karl Müller (2014), who have contributed greatly to second-order science (SOS), to which Sweeting dedicates a substantial section. This critique focuses on the important role of the scientist as an observer and active constructor of the scientific process, a role that is systematically erased from positivist accounts of scientific activity.

« 4 » Sweeting thus establishes two alignments: between design research and SOC, and between design and SOS. The question that arises in the reading of the article is the degree to which it is possible to extrapolate from the alignment between these discourses in order to draw conclusions that are applicable to science as it is carried out beyond the cybernetic tradition and to design that is carried out without a reflexive turn.

« 5 » When Glanville spoke about design, he did so not as an external observer surveying the field, but as a participant explaining his experience of the process of design (including his design of musical environments and performances). Indeed, given the view of cybernetics that he sustained and lived by, we should not expect anything less. Sweeting does not discuss Glanville's practice but implies that it was in line with Horst Rittel's argument that "'everything goes': because designers inevitably encounter new and ambiguously defined situations (it being the purpose of design to create the new), they have no well-defined problems to solve or enumerable lists of options to pick from" (§13), and that the problems encountered by designers are "wicked" (§8) because of their complex inter-dependencies. Much design practice is illuminated by an analysis conducted from this position, but many design problems are perceived by designers in much simpler terms, and are not seen as being wicked.

The Chambers Dictionary definition of the verb "design" is "to develop or prepare a plan, drawing or model of something before it is built or made," and readers will be able to confirm that other dictionaries have similar definitions. This definition includes many contexts where designers are convinced that they are working with well-defined problems, and that enumerable lists are available, including much of the field of engineering. A reading of Sweeting's article with a focus on this issue is complicated by the fact that the logic of the argument leads to thematic sections that discuss both design research (which necessarily has a reflexive aspect) and design (which, in the view of many practitioners, does not necessarily involve a self-reflexive aspect).

« 6 » The designers of scientific instruments such as the CERN particle collider have a well-defined goal, in this case to provide an apparatus capable of detecting the Higgs Boson. But even in design that does not involve engineering, well-defined problems can be identified. The builders of musical instruments provide a good example of designers who have well-defined problems with lists of options. Iris Bremaud describes the choice of woods for construction in the case of the designers of xylophones and slit-drums in Africa:

> "Many species could be encountered in either xylophones designed for temporary use, or slit drums with strong aesthetical meaning, involving the ability of wood to be intricately carved […]. On the contrary, the more prominent the purely 'acoustic' function of instruments was, the higher the proportion of use of Pterocarpus […]. This choice is nearly exclusive in most elaborate xylophones and in slit-drums that were used for message transmission – up to more than 10 km distances." (Bremaud 2012: 812)

These designers are clearly making choices from a list of predefined options, and deploying their design expertise in making the trade-off between the contrasting benefits of different materials and the range of predefined purposes to which the instrument will be put.

« 7 » In a rather different musical context, Brian Eno, often described as a sound designer, also explains the act of creating a musical composition in terms of selection:

> "What the composer had was a kind of menu, a packet of seeds, you might say. And those musical seeds, once planted, turned into the piece. And they turned into a different version of that piece every time." (Eno 2011)

Eno relates this approach to the influence of Stafford Beer, and perhaps this cybernetic connection should not be surprising given the importance of selection in cybernetics since the early work of Claude Shannon (1948).

« 8 » The purpose of this digression into music, a field that was one of Glanville's main areas of activity, is to argue that there exist design practices that are well-defined, involve selection from a list of pre-determined options, or both. I suggest, therefore, that Sweeting's characterization of design is best seen as an accurate description of a particular type of design. It may also be an argument and exhortation to other designers who do not share these ideas or practice to consider more deeply the recursion involved in their design activity, and I believe that this was the intention of much of Glanville's work. The question arises, however, how far (if at all) it is possible to make a convincing argument about design in general on the basis of this SOC analysis to those who do not share the epistemological position of the field, a challenge that is common to SOC as a whole. I see Sweeting's discussion of Andrew Pickering as being central to this question.

« 9 » Sweeting cites Pickering extensively, and mostly with approval. However, he disagrees with Pickering's characterization of SOC as "a turn away from the more tangible modes of experimentation that characterized earlier phases of cybernetics, and towards the linguistic." Sweeting counters this argument by pointing out that "SOC is a reflection on the performative involvement of observers within their observations" (§5), but that the opportunity to carry out this function was limited because the field of cybernetics had "broken up" (§19) by the time that SOC emerged. I have some sympathy with this view, but nevertheless I believe that it is incumbent on those who feel there is value in the heritage of cybernetics to investigate Pickering's point more deeply. Specifically, we need to assess the degree to which the risk that Sweeting identifies that SOC can become "overly introverted" (§6) may have played an active part in the break up of the field. Sweeting's concern is not to conduct such an inquiry into the decline of cybernetics, but rather to explore how its legacy can be applied and revived in design research. Nevertheless, I believe that there is a key point at issue here, as I now discuss.

« 10 » The examples that are given of Pickering's performative approach can indeed be situated within SOC (R. D. Laing's work on therapists, Pask and the participant observer). But there are many aspects of Pickering's thinking about the performative that are not easily situated in this way. Pickering describes his conception of the performative as an "…image of science, in which science is regarded as a field of powers, capacities and performances, situated in the machinic captures of material agency" (Pickering 1995: 7). In his book *The Mangle of Practice*, Pickering examines the history of the bubble chamber in physics research. He argues that we should see this as a "dance of human and material agency" (ibid: 51). Pickering goes on to describe how…

> "[r]esistance (and accommodation) is at the heart of the struggle between the human and material realms in which each is interactively restructured with respect to the other – in which, as in our example, material agency, scientific knowledge, and human agency in its intentional structure and its social contours, are all reconfigured at once." (ibid: 67)

Here, I think, is the heart of the problem of the generalizability of insights from SOC. The idea that the object of investigation (or design) has material agency that pushes back at the scientist (or designer) is one that sits uncomfortably with an SOC view of constructivism, and certainly of the radical constructivist tradition within SOC as exemplified by Ernst van Glasersfeld (1995). To put it another way, the conception of the performative within design research as described by Sweeting, and perhaps within SOC as a whole, may be different from that which Pickering proposes.

« 11 » In my view, SOC does not necessarily preclude the ascription of agency to the material world. For example, the reformulation of the scientific method undertaken by Humberto Maturana (1990: 18) implies constraints on our ability to engage with the

agency of the material, but it does not preclude its existence, and is compatible with Pickering's "mangle of practice." The analysis proposed by Sweeting, however, does not encompass the agency of the material. He does mention "the ways in which material artefacts operate variously as part of the research process, as the object of enquiry, as output or dissemination and sometimes as more than one of these depending on their context" (§30), but there is nothing to suggest that the physical world "pushes back" at the designer, or even that such a thing might be possible. I do not see this as a problem for the analysis proposed by Sweeting per se, as the design practice described may indeed consist of a recursive interaction between the designer, the design and the people for whom it is intended. Moreover, from a radical constructivist perspective, it may be argued that the perception of material agency is no more than a perception, and that a methodology based on this is intellectually misleading and practically unreliable. It does, however, raise a problem for the claim that design is a category that subsumes science. Sweeting's argument that scientific activity is a kind of design holds for a broad definition of design, but the specifically SOC view of design put forward in this article does not map well onto mainstream conceptions of science. The same applies even to first-order cybernetics in the performative mode, for example for Grey Walter, whose robotic "tortoises" addressed a well-defined problem: "to model goal seeking and, later, learning. But he did so as economically as he could" (Boden 2006: 244). The problem of mapping from design to science can be resolved in one of two ways. One option is to broaden our understanding of design so that it includes material agency, in line with Pickering's mangle of practice. This would enable the insight from SOC into the role of the designer in a recursive process of construction to be generalized across the whole range of scientific and design activities. Alternatively, we can make it clear that we are adopting a critical view of science, engineering and craft. This would embrace the differences between different types of design and scientific practice, and challenge practitioners to question the externality of the material agency that they ascribe to the surrounding environment and independent of themselves. There is indeed a role for such a practical critique. Sweeting refers to "pre-defined methods that were characteristic of philosophy of science" in the 1970s, but a glance around the bodies funding research today would show that this preference for pre-defined methods is alive and kicking.

« 12 » Divergent opinions on the performative may in turn account for Sweeting's disagreement with Pickering on the linguistic turn in SOC. Sweeting comments that "SOC is a reflection on the performative involvement of observers within their observations" (§5). However, material agency is at the core of Pickering's view of the performative but is not represented in design seen from a SOC perspective, as represented in this article. Consequently, from Pickering's perspective SOC is lacking an account of material agency and its effects, whereas Sweeting does not discuss any such lack. It is the discrepancy on this lack, I suggest, that leads Pickering to identify a linguistic turn in SOC, and also leads Sweeting to disagree with him.

« 13 » In conclusion, the important contribution of this article is to bring together and extend the thinking of Glanville, and to show how this can both inform design research and serve as "continuing or reinventing cybernetic concerns" (§35). In doing this, Sweeting offers a much-needed response to the lack of practical research being carried out within SOC, a concern that Glanville also shared. In doing this, the article also raises important issues, going beyond its main focus, about the nature of the relationship between second- and first-order cybernetics and the possible role of material agency as a point at issue in the understanding of the performative in these two aspects of cybernetics.

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What Can Cybernetics Learn from Design?

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> Upshot • Based on Sweeting's central question of what design can bring to cybernetics, this commentary extends and adds further depth to the target article. Aspects discussed include the nature of practice in relation to design, the introduction of designerly ways of acting and thinking through acting to cybernetics, and the re-introduction of material experimentation typical of early cybernetics.

Differentiating externally motivated application and internally motivated practice

« 1 » Ben Sweeting's focus on the relationship of cybernetics and design presents a valuable counterpoint to recent attempts at renewing interest in cybernetics by framing it primarily in reference to science (§24). Based on Ranulph Glanville's (2007c: 1178) characterization of design as the action of cybernetics, and cybernetics as the theory of design, Sweeting positions design research as a variety of second-order cybernetic (SOC) practice (§4). This central point of Sweeting's article deserves further strengthening, as practice is not to be understood in this context as the *application* of theory (§§6–10). As argued by Sweeting based on Glanville (2014a, 2015) (§3), SOC should not be conceived of as a theory preceding and determining subsequent action. When seen from the perspective (and experience) of design, theory is more appropriately understood as a framework for making explicit thoughts developed in and through action. While generated from action, such a theory can then also be used for abstract argument and analysis, but this should not be seen as its primary purpose. Design reasoning is typically implicit: a form of thinking immanent in, expressed, and developed through acting. This is illustrated in Donald Schön's (1991) well-known characterization of design processes as *reflection in action*. It is this recognition of the fundamental involvement of the observer in the process that sets